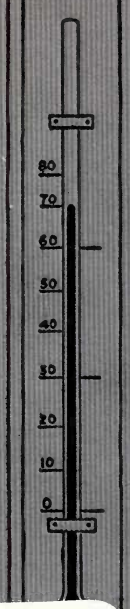
The CLIMATE OF DULUTH



The Climate of Duluth

Minnesota

BY

H. W. RICHARDSON, LOCAL FORECASTER

UNITED STATES WEATHER BUREAU

PREPARATION AUTHORIZED AND DATA APPROVED

BY

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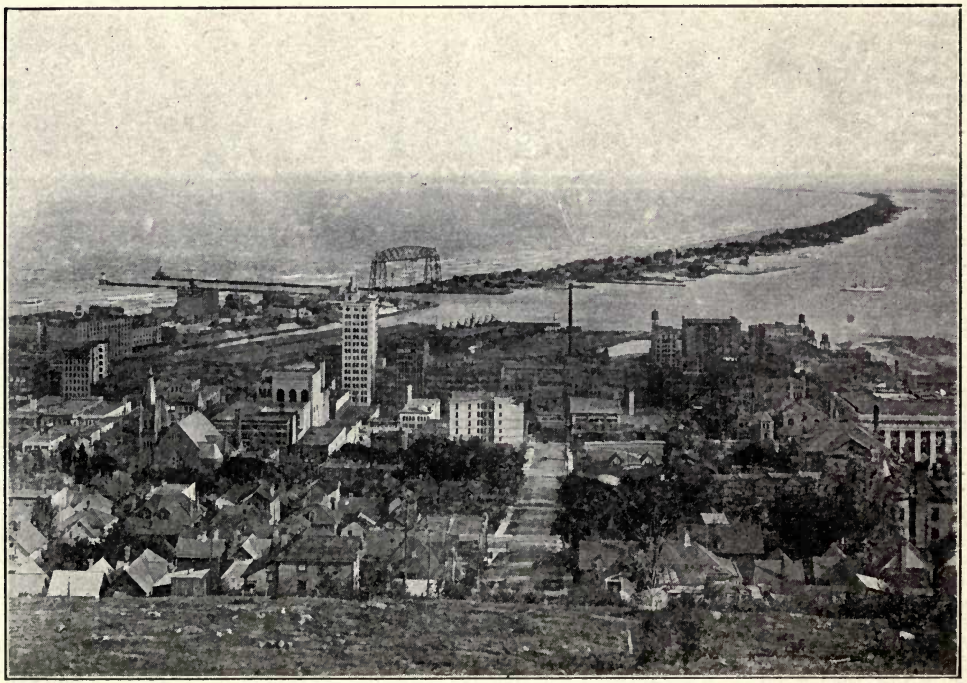
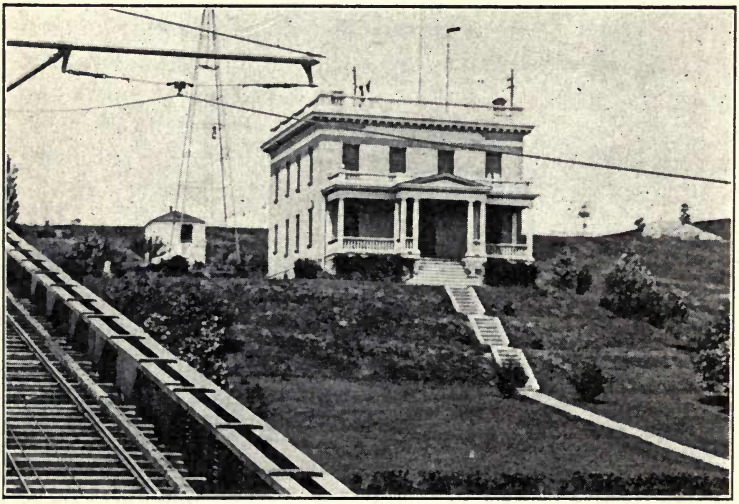


View from Duluth Boulevard

The Service of the Local United States Weather Bureau

The value of the Weather Bureau forecasts and warnings and other information as utilized by the extensive commercial interests at the Head of the Lakes is approximately $2,000,000 annually, a net return of about 30,000 per cent. on the investment or cost of operation of the Duluth station. Of the amount mentioned practically $1,000,000 is annually saved the shippers and transportation companies handling perishable freight, about $600,000 is saved the marine and iron ore interests, while at least $400,000 is the value of the service to other lines of business. These figures, while perhaps astounding, can easily be verified. The forecasts and warnings are correct 80 to about 90 per cent. of the time, and rarely does a severe storm or cold wave come in unannounced. It more often happens that such conditions may not materialize to the extent anticipated, which source of error is really on the safe side of the ledger. As stated elsewhere it is the exception that excites comment. In addition to the interests mentioned the forecasts and Weather Bureau data are more or less effectively used by local contractors and builders, farmers, gardeners, florists, dairymen, stock raisers, department stores, heating companies, managers of office buildings,

attorneys, architects, physicians, dredging companies, the Board of Trade, Bankers, logging firms, the street railway, etc., not to mention those contemplating business or pleasure trips, excursions, entertainments, lawn parties, theatre parties, and the like. Scores of illustrations might be cited showing the practical application and value of the local weather service.



The Local Office of the United States Weather Bureau, Duluth, Minnesota.

Introduction

The principal object in compiling and arranging the information contained in this publication is to present the facts concerning the climate in the vicinity of Duluth, to refute the erroneous impressions current in the minds of many, and to indicate in some slight measure the tremendous possibilities in agriculture and other lines of business in this section, for without question the region at the head of the lakes is truly the land of opportunity.

Of course this locality has some disagreeable weather now and then. What place does not? As a matter of fact equally if not more disastrous wind and snow and rain storms occur elsewhere with as great or even greater frequency than here. There are many places having winters just as cold or even colder, and as for the summer and autumn seasons there are none finer anywhere than ours, while at the same time we do not have any sand storms, tornadoes and the like; nor are there any venomous reptiles and insects to be found hereabouts.

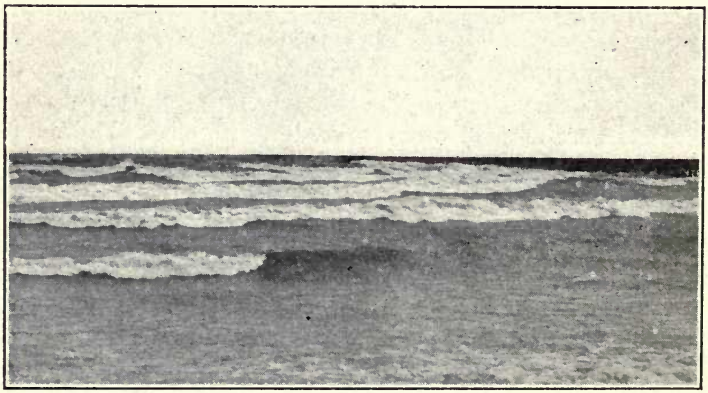
Some of our people have perhaps been too prone to dwell upon the unpleasant weather features of our climate. When we do have a storm or cold wave of any special consequence the fact has been advertised far and wide. It is the exceptional that excites comment, and

particularly newspaper comment. The average excellence of the climate is accepted as a matter of course.

The work of assembling the meteorological data presented in this book has been very carefully done, the facts have been taken from the official records, and the manuscript, charts and tables have been reviewed and approved by the Chief of the U. S. Weather Bureau.. The writer's opinions and conclusions are based on 28 years service in the United States Weather Bureau and a personal knowledge of local conditions gained by a residence of 16 years in Duluth.

H. W. RICHARDSON,
Local Forecaster, U. S. Weather Bureau.

March 14, 1914.



On the Shore of Lake Superior.

The Climate at the Head of the Lakes and its Relation to Agriculture

Thirty to forty years ago the belief was fairly general that the climatic conditions in the section adjacent to the head of the lakes were entirely unsuited to the growing of any crops except potatoes and some of the commoner varieties of garden truck, and then only when the season happened to be especially propitious. Even as recently as twenty years back comparatively little attention was paid, as a rule, to either farming or gardening except for purely personal needs, but from the commercial standpoint the possibilities of our soil and climate up to that time had received but scant consideration, although there were some who began to catch faint glimmerings of what might be accomplished if the land were cleared and rendered accessible by means of good roads.

Our people were then engaged with other and more engrossing matters. The hard times which culminated in 1893 were upon them, a period that sorely tried men's souls. With the return of prosperity attending renewed activities in all lines of commerce during the succeeding half dozen to ten years the needs of our rapidly increasing population induced a number of progressive men to investigate for themselves and spend large sums of

money in demonstration of their faith in the agricultural possibilities of this section. Prominently among these were John G. Williams, C. P. Craig, Rt. Rev. James McGolrick, G. G. Hartley, B. C. Church, W. C. Sargent, S. F. Snively, A. C. Jones and B. F. Howard. There were some others, of course, but to those named is due the principal credit for all the magnificent results being achieved now or which are in process of development. They talked agriculture at home and abroad, widely advertised our resources, and gave local agricultural a stimulus it never before had. Now the number of those is almost legion who have all the way from 1 to 1,000 or more acres either wholly or partially under cultivation. Space permits only the briefest mention of the innumerable and splendid back-yard gardens, the fine dairies hereabouts, the herds of thorough-bred and prize cattle—some of which hold world records for milk and butter-fat, the extensive and up-to-date stock farms, successful poultry plants both large and small, and numberless specialties in the way of garden and farm products.

VARIETY OF CROPS

Through the efforts of these pioneer enthusiasts and the excellent and highly organized co-operation of the Duluth Commercial Club, agricultural experiment stations, and some of the local railroad officials, much has been acomplished, enough at least to clearly prove that with the exercise of some intelligence and reasonable

industry abundant crops of a great variety and of the very highest quality can be successfully and very profitably grown in the region adjacent to the head of Lake Superior.

It is interesting to note that strawberries from Duluth received the highest award at the St. Louis Exposition, that the best bushel of potatoes grown in the United States in 1911, exhibited at the American Land Show in New York City, was from our county, that the Allandale and Island Farms respectively furnish the finest head lettuce and celery that go to the Chicago and St. Louis markets, while the Jean Duluth Stock Farm Dairy and the Sebenius Dairy compare with the best in the land. An excellent opportunity is afforded to make large profits from growing strawberries for the late market, as they are coming on locally when gone elsewhere. Corn for ensilage is being raised on an extensive scale. Clover, timothy and alfalfa grow luxuriantly here, and the grass continues green and succulent and plentiful until snow flies. This unexcelled grazing condition is largely due to the high moisture content of the air in the late summer and autumn and the increase in amount of precipitation in September (principally the latter), aside from such considerations as the nature of the soil, this being liberally provided with the required plant food, etc. The climate and soil favor practically all of the grain crops. Gardens, root crops, small fruits, berries, flowers and shrubbery flourish here as nowhere else on account of soil, rainfall, humidity, temperature, wind and sunshine conditions. Some varieties of apples and

tomatoes yield abundantly, the size being large and the quality excellent. It is also entirely probable that within the next few years grapes may be growing on some of our hillsides. Potatoes (the very finest in quality) average 300 bushels and better per acre, much depending upon good seed and cultivation. The writer knows personally of an instance where an average of 15 bushels of potatoes is obtained annually from a patch 14 feet by about 75 feet in area. The soil in this case is common hereabouts, sandy loam, high in phosphorus, well fertilized, and cultivation is intensive. This is mentioned merely to illustrate the possibilities of backyard gardening in its relation to the problem of the high cost of living.

NO CHANGE IN CLIMATE

Such splendid results have led a few to imagine that our climate has changed since pioneer days. The official records of the weather do not show any appreciable change in 43 years in any of the various elements which comprise our climate. A permanent climatic change would ordinarily require ages of time or else a sudden and gigantic convulsion seriously affecting vast areas of either the earth's surface or that of the sun. We have no record of either since written history began. The aridity of vast areas of the Nile basin, for instance, is perhaps due more to political causes than any other, and now that irrigation is again possible there on a large and well regulated scale, its verdure will soon be as abundant as it was reputed to be in the days of the

Pharoahs. Geological conditions go to prove also that to bring about a permanent change in climate a period of say 10,000 to 20,000 or more years must elapse to include some of the processes necessary for the effects of time alone. Our winters are just the same, on the average, as they were in pioneer days, and our summers and autumns and winters and springs are neither warmer nor colder nor wetter nor drier on the average than then. One reason that impels us to think that the winters of early days were colder than in recent years is because of the rather primitive means of combatting the cold then in comparison with present facilities. Besides, time usually has its influence in magnifying events of the long ago, and records obtained from the common and cheaply constructed thermometer and its imperfect exposure are certainly unreliable as to accuracy. Extremes of moisture and dryness, and heat and cold, quite often follow each other through the years in the form of rather uneven curves or cycles whose periods require say 5, 10, 15, 20, and sometimes 30 or more years to consummate before the occurrence of the inevitable swing back to normal or the opposite condition. In general, the world over, it may be said there is a more or less irregular procession of lean and fat years, each covering varying periods of time, in some cases probably due to the effects of sun-spot variations, changes in electrical potential of the atmosphere, varying amounts of volcanic dust in the air, abnormalities in storm paths, etc.

The fact that we can successfully and profitably raise live stock, and grow vegetables, fruits, grains,

Head Lettuce Field at Duluth.

shrubbery and magnificent flowers at the head of the lakes now should really be attributed to the processes of development, selection and adaptation of species to environment, a better understanding of our climate and soil, intelligent cultivation of crops, and the proper care of live stock.

The region hereabouts is one of the most favored and healthful and picturesque to be found anywhere. There is an abundance of sunshine and moisture and temperature during the growing season. Tornadoes have never occurred in this section, the topographic and water conditions do not favor their happening; while the real plains blizzard is practically an unknown feature. It is true our winters are cold, but, they are quite endurable, and the weather then is nearly always a "dry cold" because of the prevalent westerly (off the land) winds. Besides, the outdoor sports made possible by the low temperature and snow and ice conditions are certainly compensating features which add to our good health and pleasure. At this time, too, there is, on the average, by weight, more oxygen in a given volume of air than at other seasons. This increase in oxygen tends to stimulate the processes of combustion, which in turn has its energizing effect upon most forms of animal life, including human beings. And also because of the dryness stock winters well and even better than in many sections in the central valleys, and eastern and southern states, as ordinarily we do not have such decided alterations of temperature, for the cold then is rather steady, practically all the precipitation is in the form of

snow and it is generally dry and packed hard, and slushy snow is a very rare condition, while severe sleet storms occur but seldom—the actual average is less than once per year. The ground frequently freezes to a considerable depth, but this is regarded as beneficial than otherwise, because of the resultant aeration of the soil attending thawing operations in the spring, etc.

COOL IN SUMMER

During the warmer season of the year the extended periods of debilitating and blighting heat, so frequently experienced further inland, do not invade this favored region. Of course, rather warm spells occur now and then, but they are of very brief duration, seldom lasting more than two or three days at a time. Maximum temperatures varying from 70° to 80° are quite the rule during the summer months, but temperatures of 90° or higher occur only about twice per summer in the section immediately adjacent to the western end of Lake Superior. The night temperatures in the summer are generally so cool that one feels comfortable sleeping under a blanket. It has been stated that the average coolness of the nights in great measure imparts a vigor, freshness and crispness to certain of the garden crops not attainable in many other sections.

The frequent heavy dews and the occasional fog periods materially assist the growth of vegetation, especially the grasses. From a dairy and stock raising standpoint this region is easily one of the best in the United States, in fact it is doubtful if there is better anywhere.

During the growing season, say the 144 days from May 10 to September 30, the amount of possible sunshine totals 2069.6 hours, 50 to nearly 75 per cent. or more of which time the sun is actually shining, the longest day being June 21 with 15 hours and 55 minutes possible sunshine. The grand total referred to is approximately 24.5 hours more possible sunshine in the same period than in the vicinity of St. Paul, 45.2 hours more than at Des Moines, and 87.4 hours more than at St. Louis. The 144-day period is more than sufficient, in fact 100 to 125 days—on account of the long hours of sunshine and ample amounts of warmth and moisture, rich soil and proper cultivation of the latter—will mature most of our crops.

The average date of the last killing frost in spring is May 3, and the average of the first in autumn is October 4, 43-years record.

PRECIPITATION

The annual precipitation is close to 30 inches of water (including rain, melted snow, etc.), about 18 inches of which falls during the growing season, ranging from about 30 inches in the wettest growing season to nearly 12 inches in the driest. But even in the latter instance (season of 1910, driest of record), where crops were either indifferently or well cultivated the yields ranged from good to excellent. At this point it might be of interest to mention the fact that water an inch in depth will measure 22,624 gallons to the acre. This will afford some idea as to rainfall when considering quantity. Of course not

all goes into the ground, such matters as topography and character of soil, run-off and evaporation must also be considered in studying precipitation efficiency.

It is of especial interest to note that the LEAST amounts of rain ever recorded at the head of the lakes during both the whole year and the growing season, represent practically the NORMAL amounts for those periods in the region from the Dakotas southward through the central and western portions of Nebraska and Kansas to including central and western Texas.

About 53 inches of snow (unmelted) falls each winter, and the ground is usually snow covered continuously from late in November to early in April. The maximum accumulated depths generally range from 5 to 20 inches, rarely exceeding 20 inches except in the forests or where drifts occur. As already stated, this snow is nearly always dry, it packs hard and affords excellent sleighing, and its disappearance is rather gradual as a rule, by far the major portion of it evaporating into the air.

The average hourly wind movement is moderate in winter and light ordinarily in summer. Calms are unusual and the wind force is generally ample for the continuous operation of wind mills in cases where such power is preferred for use in connection with pumps and farm machinery. Wind storms occur occasionally, but their strength and frequency compare favorably with other sections of the country, and tornadoes, as already stated, are an unknown feature in this locality. In summer, autumn and winter there are often long stretches of the most magnificent weather, in fact nature seems to have favored this region in many and unusual ways.

Climatology of Duluth, Saint Louis County, Minnesota

Duluth lies on and at the base of a range of hills that rise rather abruptly in the highest places 600 and 800 feet above the level of Lake Superior, the trend of the range being northeast and southwest, but two or three miles back from the water front the country assumes the character of a more or less level to rolling plateau. The city proper extends along the west banks of the St. Louis River, Spirit Lake, St. Louis and Superior Bays and Lake Superior, including Grassy, Rice's and Minnesota Points. Directly opposite, on the flats occupying the east banks of the St. Louis River and St. Louis Bay, and the south banks of Superior and Allouez Bays, lies the city of Superior, Wisconsin, the two cities being connected by a swing bridge at the intersection of St. Louis and Superior Bays. The corporate limits of Duluth extend about 24 miles northeast and southwest, the greatest width being about 3 miles. The middle part of the city is in lattitude 46° 47' N, and longitude 92° 6' W.

The Duluth meteorological station was established by the U. S. Signal Service on October 18, 1870. It has been in continuous operation since then, by the Signal Service until June 30, 1890, and after that date by the U. S. Weather Bureau. Quarters in the Edmonds Block (east corner Lake Avenue and Superior Street) until

June 30, 1882; the old St. Louis Hotel Building from that time until November 30, 1884; the Metropolitan Block until January 29, 1895; and the Post Office (Government) Building to December 31, 1903. Since the latter date the Weather Bureau has utilized its own building (a two story and basement structure), which faces towards the harbor (southeast), located on the easterly side of 7th Avenue West, between 7th and 8th Streets and near the hill-top station of the 7th Avenue Incline Railway. The grounds (100 by 300 feet) are of a bench-like formation near the top of an otherwise sloping hillside. The view northeast around by east to south embraces a range varying from 1 to nearly 70 miles, and includes Lake Superior, the cities of Duluth and Superior, practically the whole harbor, and much of Wisconsin.

The barometer is 532.17 feet above Lake Superior and 1133.37 feet above sea level. The rain and snow gages are on the ground about 30 feet southwest of building and mounted on a 3 ft. by 6 ft. cement base, a lead-covered underground cable connecting the rain gage with the register apparatus in offices. The thermometer shelter is on the ground 50 feet in rear (northwest) of building. The shelter is the regulation pattern, mounted on galvanized steel supports, the thermometers being 10.5 feet above sod. The anemometer, wind vane and sunshine recorder are all located on the (flat) roof of building, the anemometer cups being 47.1 feet above ground, and the wind vane 48.3 feet. The basement window sills of building are 525.52 feet above the mean level of Lake Superior.

In a Duluth Park.

INFLUENCE OF LAKE SUPERIOR

The proximity to Lake Superior, which is the largest and the coldest of the Great Lakes, materially influences the local climate, especially in spring, summer and autumn months, when the prevailing winds are from the northeast and off the Lake. The effect of the range of hills on the northwesterly side of Duluth and those further to the eastward in Wisconsin, which bound the St. Louis River Valley, is also important, the combination apparently acting so as to promote an atmospheric indraft from the Lake, particularly in the warmer months. Sometimes, in mid-summer the local temperature attending the occasional strong northeast winds will be so cool that light overcoats and grate fires may be necessary in those parts of the city adjacent to the water front, while from 1 to 4 miles back of the range of hills the temperature may be fine and moderate, and 5 to 10 miles still further inland the weather may be swelteringly warm.

Clear to partly cloudy weather is quite the rule if the northeast wind is light to moderate in force, and the temperature will then be mild to moderately warm; but fog, chilly temperature, and rain usually attend strong northeast winds. In the summer the land winds are usually warm, southwest winds being attended by high temperature generally. In the winter months the land winds (except south) are ordinarily cold and the Lake winds relatively warm, particularly if there is open water. The heaviest snow storms occur in connection with moderate to strong northeasterly winds.

Many misrepresentations concerning our local climate have been accepted as facts by the public generally, and some of these statements, on account of exaggeration or by being based on the records of extremely inaccurate thermometers with imperfect exposure, border somewhat on the ridiculous. For instance: The writer has often heard it stated and in all seriousness that the temperature in Duluth reaches 40° below zero dozens of times every winter. That is altogether wide of the mark. Tourists and other visitors to our offices frequently make such assertions as solemn fact, and the writer has had many inquiries by telephone and mail as to the truth of this legend.

The temperature, as officially recorded by the Weather Bureau (including the records of the Signal Service regime), has reached 40° below zero but once in 43 years, (ie, 41°, January 2, 1885.)

As a matter of fact the official records further show that in these 43 years the temperature has fallen to 30° or more below zero (but not to 40° except in the above single instance) 4 times in all the Decembers, 26 times in all the Januarys, and 6 times in all the Februarys, an average of not quite once each winter.

The first zero temperature has occurred as early as November 12 (1911) and as late as January 11 (1914), while the last occurrence has been as early as January 28 (1878) and as late as March 29 (1885 and 1887.)

COLD AND WARMTH RELATIVE

On the whole, atmospheric cold and warmth are somewhat relative terms, and their effects upon an individual depend upon many things. In a given locality the cold, or the heat, may be relatively dry or relatively moist on occasions. In the one case a person might be exceedingly uncomfortable at a temperature of 10° above zero with a high humidity and windy weather, and not suffer any special inconvenience with a temperature of 25° below zero with still air and moderate humidity. Much also depends upon the personality of the individual, his physical condition, his mental temperament, and clothing worn. A temperature of 95° at say 50 per cent. relative humidity would not be as uncomfortable as a temperature of 75° or 80° at a relative humidity of 95 per cent. or 90 per cent., respectively. In the former case the warm and dry air would evaporate more or less moisture from a person's body and thus lower the surface temperature somewhat, while in the latter instance the evaporation processes are reduced to a minimum and the resultant effect of warmth and moisture one of great discomfort.

In June, July and August the daily maximum temperature averages about 71° and the minimum 54°. About 3 consecutive days is the usual limit on any local hot wave with temperatures 85° to 90°, while elsewhere such periods commonly extend 10 days to two weeks at a time with maximum temperatures of 95° to 100° or higher, and with the lowest night temperature often rang-

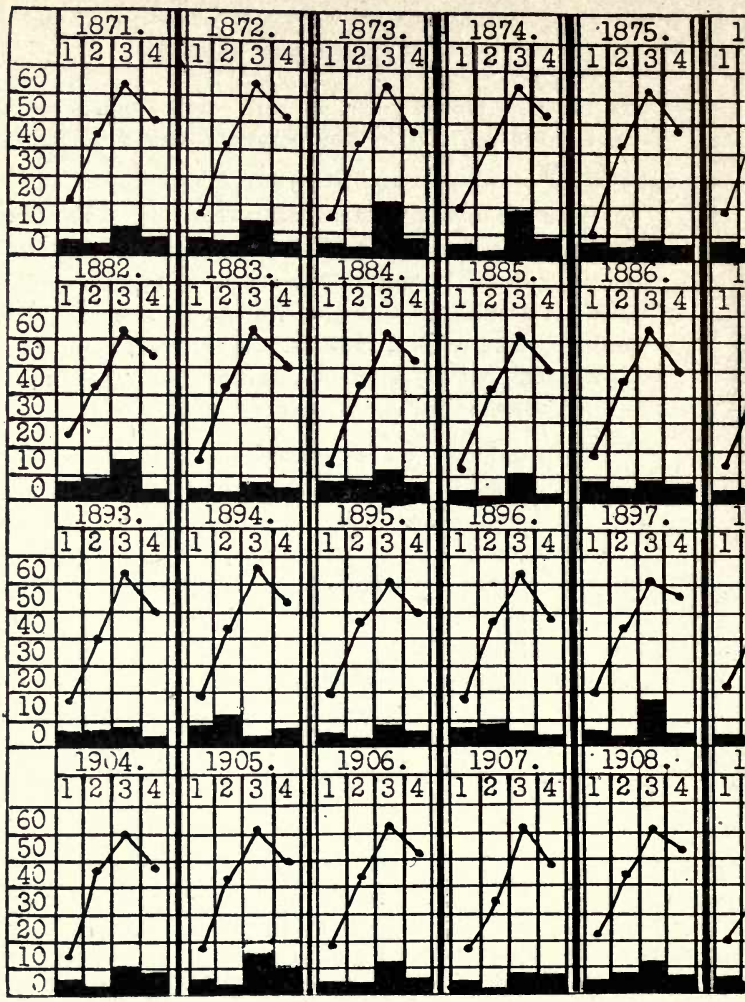
ing from 75° to 80°. At Duluth, even during the warm waves referred to, the temperature at night seldom exceeds 65°.

The mean annual temperature is 39°. The average of the spring months is 37°; summer, 63°; autumn, 43°; winter, 13°. Average of the warmest spring, 43°, 1878; warmest summer, 66°, 1878; warmest autumn, 48°, 1899; mildest winter, 32°, 1877-8. Average of the coldest spring, 32°, 1888; coolest summer, 59°, 1891; coolest autumn, 39°, 1896; coldest winter, 5°, 1903-4.

On the average the sun shines about 55 per cent. of the time possible, the greatest being 65 per cent. in July; and the least, 45 per cent. in November and December. These amounts are more than ample for all purposes and compare favorably with other sections to the eastward of the Rocky Mountains. The longest day is June 21st with practically 16 hours of possible sunshine, and the shortest is December 21st with 8 hours and 30 minutes possible sunshine. From May 1 to September 30 there are, on the average, 111 clear and partly cloudy days, 42 cloudy days, and 61 days with .01 inch or more precipitation.

The climate at the head of the lakes cannot be regarded as humid, even in the popular sense. There is, however, just the right balance between the temperature and the water vapor actually present in the atmosphere which makes for personal comfort in general, and a splendid effect on all forms of vegetation during the growing season.

Seasonal Mean Temperature and Total P



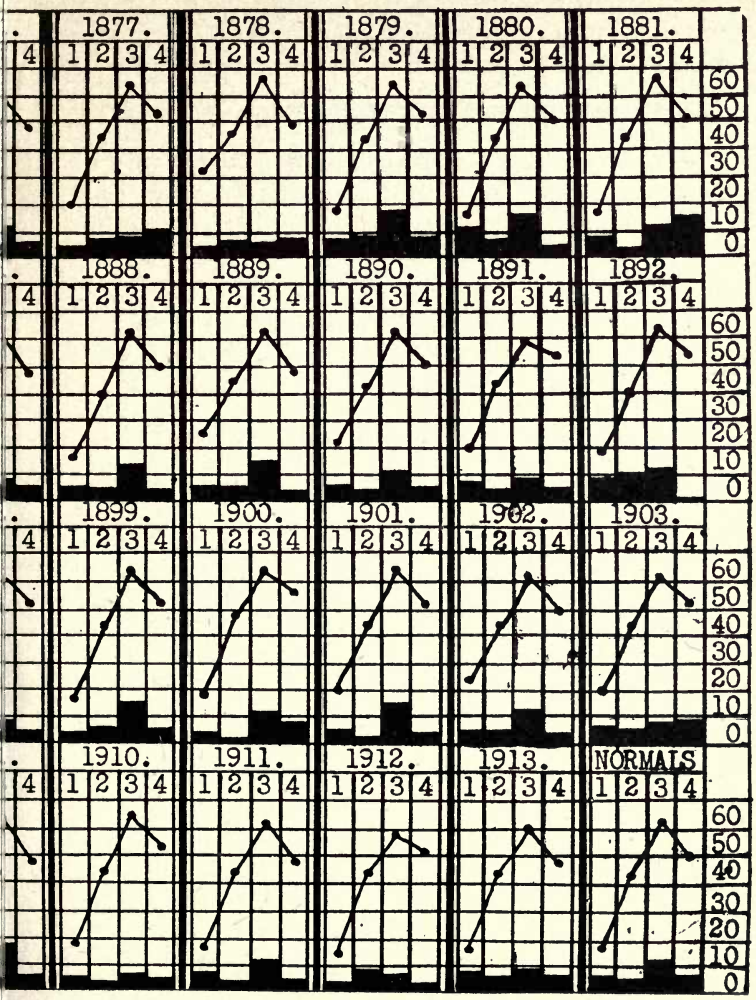
EXPLANATORY NOTES

Continuous lines, mean temperature for period, degrees Fah
Column 1 includes November, December, January, February
Column 2 includes April and May.

REMARKS: The above table shows a rather decided ten to October, inclusive, comparing similar periods; while the more inclusive though the cold weather in the winter months is inc

The seasonal distribution of precipitation is as follows: N May, 19 per cent.; June, July and August, 39 per cent.; Septem

cipitation, 43 Years. Duluth, Minnesota.



R "SEASONAL" CHART.

neit. Shaded areas, total precipitation for period, in inches.
d March. Column 3 includes June, July and August.
Column 4 includes September and October.

cy towards stability in the mean temperature conditions, April
ided variations usually occur in the period November to March,
l to be somewhat steady.

mber to March, inclusive, 21 per cent., mostly snow; April and
and October, 21 per cent. of the annual amount.

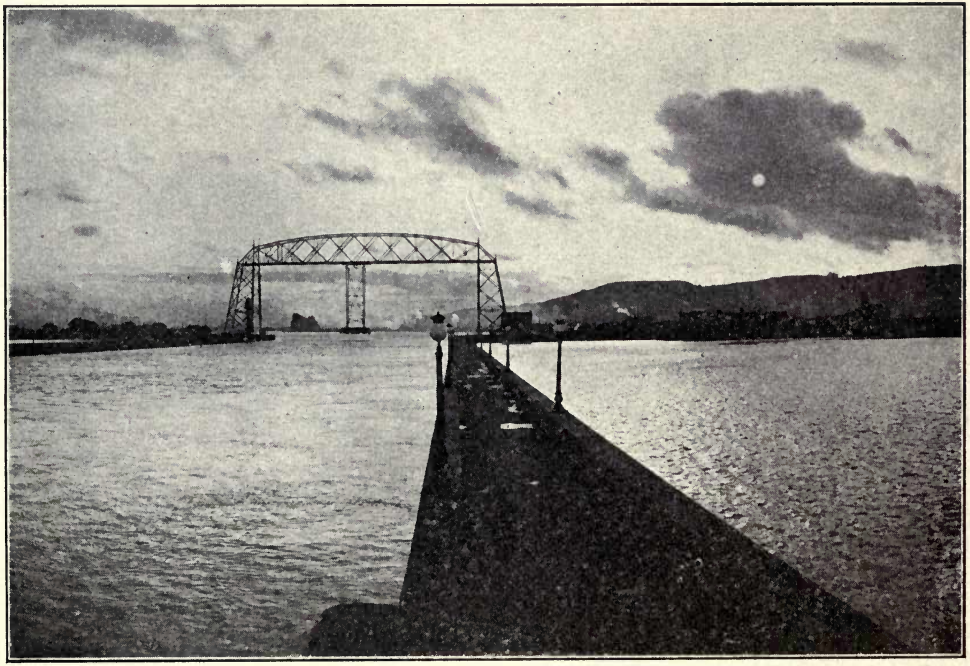
PRECIPITATION DISTRIBUTED

The precipitation (rain, snow, etc.) is well distributed to meet the varying needs of the seasons. In general the heaviest rainfalls occur during the warmer months in connection with thunderstorms. The greatest amount of rain in any 24 consecutive hours was 5.35 inches on the night of July 21-22, 1909. On this occasion .50 inches fell in 5 minutes (at the rate of 6.00 inches per hour), .84 inch in 10 minutes, 1.07 inches in 15 minutes, 1.61 inches in 30 minutes, 2.37 inches in 1 hour, and 2.68 inches in 2 hours. The greatest total precipitation in any month was 11.52 inches in September, 1881, and the least was 0.07 inch in December, 1905. The greatest annual precipitation was 45.28 inches in 1879, and the least was 18.11 inches in 1910. The drouth in this latter year was unprecedented, 115 days (March 1 to July 5); the rains that actually fell were only light and scattered. From March 1 to August 31 the total rainfall was 9.43 inches, but half the usual amount for that period, while in June there was only .11 inch, whereas that is normally the wettest month, 4.15 inches being the 43-year average. Despite the unusually dry weather that year local crops gave excellent returns where well cultivated. In this year copious rains came in September, which greatly revived pastures.

The annual snowfall has ranged from 90 inches in 1886 to 27 inches in 1895, the average being 53 inches. The greatest snowfall in any 24 hours was 13.2 inches on March 9, 1892. This storm was attended by a 50-mile

northeast gale which continued until the morning of the 10th.

The average hourly wind velocity is 13 miles, a rate of about .59 pound pressure per square foot, which is moderate and compares favorably with the records for other places. The prevailing wind direction is from the northeast in all months, except southwest in November, December and January, and northwest in February. Very few gales of 40 miles or more per hour occur in the late spring, summer or early autumn months, and the high winds in all seasons come from either the northeast, southwest or northwest quadrants, as a rule. A strong southeast wind is very uncommon, in fact rare. The most severe local storm of record (as regards continuity and effects) was the northeaster and snow storm on November 27-28, 1905. On this occasion average hourly velocities of 42 miles were maintained for 29 hours, 50 to 60 miles per hour for 15 hours, and rates of 60 miles per hour for 13 hours, while the maximum rate for any 5 minute period was 68 miles. No other local storm has ever approached this one as to continuity. Higher velocities have occurred in other storms, but only for short periods, while it is rather seldom that the ordinary severe gale at its height lasts more than 6 to 12 hours. In the matter of gales and their strength, continuity and results, our record compares well with other sections, in fact somewhat to our advantage when considering the Atlantic and Gulf coasts and some ports in the Lake Region. Harbor ice begins to form locally late in November and disappears early in April. In the lake the maximum



Entrance to Duluth Harbor.

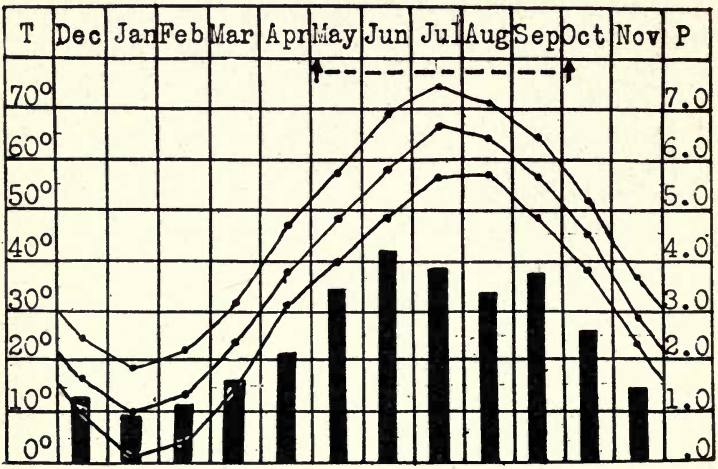
thickness of ice is attained between February 10 and March 25. The field usually extends several miles down the lake.

The average date of opening local navigation is April 7th, ranging from March 1 to May 8, while the date of closing has varied from December 15 to February 17.

April 19 was the average date of the first arrival from the lower lakes, while December 5 was the average date of the last departure for the lower lakes during the 30 years 1870 to 1899. But in the years 1900 to 1913 the average date of such early arrival has been April 21 and the last departure December 15.

An examination of the charts and tabulated matter given in this book will bring out many facts as to temperature, rain, snow, sunshine, frost, etc., valuable to the agriculturist, business and professional men, the student of climatology, and all who may be interested in our climate. In many respects the charts and tabulated data show conditions that are practically the last word in the way of extremes, and in view of the length of the record it is doubtful if some of these will ever be exceeded, and perhaps some of the conditions shown will continue indefinitely as the average and the extreme.

For certain other features in regard to climatology see the chapter on Climate at the Head of the Lakes and its Relation to Agriculture.



↑---↑Indicates average dates (May 3 to Oct. 4) between which killing frosts are not likely to occur.

Upper line, average maximum temperature (day).
Middle line, mean monthly temperature.
Lower line, average minimum temperature (night).
Temperature expressed in degrees Fahrenheit.
Broad vertical lines indicate precipitation, in inches.

CLIMATOLOGICAL SUMMARY, 43 YEARS RECORD, DULUTH, MINN.

Month.	Temperature.							Precipitation.						Mean Humidity				Wind.	
												Snow.							
	Means.	Mean Highest Day.	Mean Lowest, Night.	Highest Monthly Mean.	Lowest Monthly Mean.	Absolute Maximum.	Absolute Minimum.	Mean.	No. of days .01 inch or less.	Total Amounts, Wettest Year.	Total Amounts, Driest Year.	Average Depth.	Greatest fall in 24 hours.	Relative (per cent.) 7 a. m.	Relative (per cent.) 7 p. m.	Absolute (in grains) 7 a. m.	Absolute (in grains) 7 p. m.	Prevailing direction, from	Average hourly velocity.
Dec.	17	25	10	33	5	54	-34	1.24	11	3.89	0.56	8.8	13.2	82	77	0.85	1.00	SW	14.1
Jan.	10	18	1	21	-7	51	-41	0.97	10	0.72	0.80	9.7	10.4	82	76	0.61	0.75	SW	14.1
Feb.	13	22	4	31	-2	58	-36	1.01	9	1.46	1.13	10.0	9.1	82	74	0.61	0.76	NW	14.2
Winter Means or Totals	13	22	5					3.22	30	6.07	2.49	28.5		82	76	0.69	0.83	SW	14.1
Mar.	24	32	15	38	15	70	-26	1.51	10	1.91	0.44	11.3	12.0	80	70	0.94	1.19	NE	14.4
April	38	46	31	45	32	82	3	2.04	9	0.90	1.40	4.1	8.0	78	67	1.78	1.91	NE	14.7
May	48	57	40	54	39	88	16	3.44	12	7.99	1.18	0.9	6.0	76	64	2.60	2.70	NE	14.8
Spring Means or Totals	37	45	29					6.99	31	10.80	3.02	16.3		78	67	1.77	1.93	NE	14.6
June	58	69	48	66	54	97	33	4.15	14	5.57	0.11			78	67	3.65	3.85	NE	11.8
July	66	74	56	72	60	99	43	3.96	12	10.42	3.89			78	64	4.79	4.64	NE	11.4
Aug.	64	71	57	70	57	95	40	3.38	12	1.58	2.41			80	68	4.60	4.92	NE	11.5
Summer Means or Totals	63	71	54					11.49	38	17.57	6.41			79	66	4.35	4.47	NE	11.6
Sept.	56	64	49	63	52	94	28	3.68	11	5.24	4.20		1.5	80	69	3.62	3.83	NE	12.6
Oct.	45	52	38	54	41	80	8	2.55	10	3.95	0.81	0.3	2.5	80	70	2.45	2.57	NE	13.6
Nov.	29	36	23	41	20	73	-29	1.49	10	1.65	1.18	8.1	10.0	82	76	1.39	1.54	SW	13.8
Autumn Means or Totals	43	51	37					7.72	31	10.84	6.19	8.4		81	72	2.49	2.65	NE	13.3
Annual Means, totals and Extremes	39	47	31			99 July. 1 1883	-41 Jan. 2 1885	29.42	130	45.28 1879	18.11 1910	53.2	13.0	80	70	2.32	2.47	NE	13.4

Temperature expressed in degrees Fahrenheit.

Precipitation (rain, melted snow, sleet, etc.) in inches and hundredths.

An inch of rain measures about 22,624 gallons of water per acre.

Relative humidity is the ratio or percentage of water vapor present compared with saturation at a given temperature.

Absolute humidity is the actual amount of water vapor present in a given quantity of air. Usually expressed in grains per cubic foot.

MISCELLANEOUS DATA, 43 YEARS RECORD.

Duluth, Minn.

Months.	Total number of days temperature 90° or above.	Average number of days temperature of zero or below.	Average number clear and partly cloudy days.	Average number of cloudy days.	Average per cent. of the possible sunshine.	Average number of days with fog.	Average number days with thunderstorms.	Maximum precipitation in 24 hours. inches.	Highest wind velocity, direction and date.	Average number of winds 40 miles per hour or higher
Dec.	0	8	19	12	45	1	0	1.84, 3–4, 1891.	65-NW, 27, 1904.	1
Jan.	0	15	21	10	50	1	*	0.95, 29, 1881.	71-NW, 29, 1909.	2
Feb.	0	11	19	9	55	1	*	1.10, 24, 1871.	60-NE, 9, 1909.	2
Mar.	0	4	21	10	50	1	*	1.25, 9, 1892.	62-NE, 10, 1878.	2
Apr.	0	0	20	10	52	1	1	2.23, 14–15, 1886.	70-NW, 26, 1912.	1
May	0	0	21	10	55	2	3	3.45, 11–12, 1879.	60-NE. 22, 1877.	1
June	14	0	21	9	60	2	5	3.58, 23–24, 1901.	63-NE, 3, 1904.	1
July	41	0	25	6	65	2	6	5.35, 21–22, 1909.	56-NW, 23, 1907.	‡
Aug.	13	0	23	8	60	2	4	2.82, † 2–3, 1888.	51-NW, 19, 1904.	‡
Sept.	2	0	21	9	60	1	2	2.96, 24, 1873.	78-NE, 16, 1881.	1
Oct.	0	0	19	12	50	1	1	2.01, 9–10, 1904.	58-NW, 12, 1909.	1
Nov.	0	2	17	13	45	1	*	1.31, 5, 1876.	70-NW, 24, 1905.	1
Totals or Means	70 —	40 —	247 20	118 10	— 55	16 1	— —	— —	— —	— 13

*2 in January, 1 in February, 14 in March, 4 in November, in 43 years.
†Also 10-11, 1909.
‡17 in July and 11 in August in 43 years.

COMPARATIVE DATA.

Monthly and Annual Precipitation (Inches and Hundredths). Duluth, Minn.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
1871.	2.44	1.32	1.18	3.97	1.40	3.16	4.73	2.14	3.15	4.19	1.47	2.05	31.20
1872.	0.86	0.46	0.85	1.80	4.62	4.46	5.84	2.84	5.01	0.42	2.48	0.48	30.12
1873.	0.75	0.93	2.29	0.30	3.89	9.90	8.50	2.45	5.16	2.31	1.59	0.66	38.73
1874.	0.58	0.61	1.82	0.49	1.80	10.89	2.62	5.62	5.59	3.07	1.97	1.37	36.43
1875.	0.86	0.98	2.17	2.82	2.45	1.84	0.47	6.19	3.77	2.60	1.78	1.10	27.03
1876.	0.69	1.03	2.16	1.99	3.74	4.69	4.03	3.92	4.21	2.15	2.79	0.87	32.27
1877.	1.45	0.10	0.79	1.20	7.24	4.89	3.57	1.48	5.67	4.92	1.05	1.95	34.31
1878.	0.55	0.32	1.34	5.18	2.83	4.81	2.53	0.52	4.68	3.55	0.69	1.09	28.09
1879.	0.72	1.46	1.91	0.90	7.99	5.57	10.42	1.58	5.24	3.95	1.65	3.89	45.28
1880.	1.21	1.57	2.43	3.17	4.31	10.40	1.98	4.35	1.86	2.32	2.91	1.54	38.05
1881.	1.65	1.79	1.46	1.10	1.77	2.52	1.84	7.36	11.52	3.76	2.58	0.20	37.55
1882.	0.57	2.02	3.05	2.51	7.14	6.72	4.92	3.47	1.29	3.56	1.66	1.11	38.02
1883.	1.12	0.78	0.38	1.20	2.07	4.14	2.48	0.98	2.21	3.19	1.63	3.02	23.20
1884.	0.67	2.71	1.32	3.64	5.17	1.13	3.45	6.92	4.70	3.47	0.95	1.22	35.35
1885.	0.61	0.32	0.77	0.89	1.53	4.82	3.46	2.51	2.35	0.79	1.37	0.54	19.96
1886.	2.26	1.81	1.07	4.97	1.93	5.35	1.48	2.23	6.05	2.45	2.84	0.93	33.37
1887.	1.62	0.81	0.55	1.58	4.93	2.71	4.17	1.53	2.68	3.34	1.99	2.65	28.56
1888.	1.53	0.24	0.81	1.97	4.12	5.54	3.86	4.17	2.27	1.68	0.87	0.25	27.31
1889.	1.34	1.38	1.67	3.35	2.05	1.85	5.53	7.87	4.02	0.34	0.87	1.77	32.04
1890.	0.87	1.09	1.16	1.75	2.24	3.33	3.51	3.62	2.39	3.03	0.91	0.19	24.09
1891.	0.67	2.07	3.13	1.71	2.28	2.67	3.82	3.11	3.31	1.83	1.11	3.76	29.47
1892.	0.48	1.46	2.02	3.70	6.54	5.32	2.18	4.28	0.32	0.38	1.69	0.15	28.52
1893.	1.06	1.64	2.28	3.64	2.31	1.59	3.76	1.51	1.04	1.84	0.76	1.91	23.34
1894.	1.51	0.25	4.30	5.85	5.62	1.80	0.92	1.08	2.08	4.99	1.43	1.87	31.70
1895.	0.75	0.48	0.48	0.73	2.13	4.62	3.03	1.67	5.96	0.09	1.65	0.71	22.30
1896.	1.30	0.19	1.59	4.06	5.18	2.00	1.74	2.41	1.00	3.46	3.42	0.84	27.19
1897.	1.48	2.21	1.34	0.72	1.63	3.48	9.29	3.91	3.14	2.11	0.78	0.85	30.94
1898.	0.38	0.89	0.75	0.41	3.30	3.52	1.33	3.39	1.21	3.39	0.94	0.19	19.70
1899.	0.67	0.66	0.82	1.33	4.66	7.10	1.82	6.18	2.05	3.54	0.61	1.18	30.62
1900.	0.71	0.28	0.94	0.39	0.62	1.05	3.94	6.15	4.80	3.07	0.54	0.65	23.14
1901.	0.36	0.72	1.95	1.23	0.97	9.09	4.39	1.70	2.30	2.01	1.28	0.68	26.68
1902.	0.74	0.70	0.77	1.09	3.89	3.68	4.54	3.30	1.52	2.03	1.85	2.03	26.14
1903.	0.83	0.67	1.87	2.16	3.54	0.79	3.50	3.80	4.76	3.84	0.95	1.30	28.01
1904.	0.20	1.25	1.67	0.50	1.48	3.78	3.82	2.47	3.48	4.66	0.24	0.90	24.45
1905.	0.78	0.42	1.05	1.97	2.46	8.75	4.02	3.55	7.72	2.49	2.49	0.07	35.77
1906.	1.78	0.30	0.95	1.51	3.38	7.05	0.97	3.95	3.66	2.34	1.68	1.21	28.78
1907.	1.07	0.71	1.56	0.92	1.60	1.59	3.41	4.28	6.71	0.95	0.53	0.54	23.87
1908.	0.33	1.14	1.54	2.07	5.73	4.48	5.34	2.10	3.55	2.97	1.32	0.48	31.05
1909.	1.02	1.34	0.78	2.15	1.87	1.33	10.83	4.91	3.28	2.15	2.16	1.83	33.65
1910.	0.80	1.13	0.44	1.40	1.18	0.11	3.89	2.41	4.20	0.81	1.18	0.56	18.11
1911.	1.12	1.89	1.66	1.09	3.45	2.76	5.83	3.02	3.35	1.37	2.59	2.17	30.30
1912.	0.47	0.27	0.43	2.58	5.00	1.32	2.24	3.25	1.80	0.68	0.21	2.19	21.34
1913.	0.75	1.09	3.25	1.75	4.82	2.03	6.18	1.26	3.32	3.33	0.74	0.17	28.69
Mean	0.97	1.01	1.51	2.04	3.44	4.15	3.96	3.38	3.68	2.55	1.49	1.24	29.42

AVERAGE OF DAILY MAXIMUM TEMPERATURES FOR 33 YEARS.

Duluth, Minn.

Days.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1...	20	18	28	40	51	61	72	72	71	59	44	27
2...	17	19	29	39	52	59	70	73	69	59	45	26
3...	16	18	28	40	52	60	71	74	69	58	45	27
4...	19	18	26	41	53	63	70	74	72	56	43	29
5...	21	22	28	43	56	62	72	74	68	54	43	28
6...	20	24	30	41	52	62	74	75	68	56	42	29
7...	20	25	31	43	54	64	76	74	70	57	42	25
8...	20	23	31	43	55	64	74	75	68	56	41	26
9...	18	22	33	45	55	61	76	73	67	55	40	26
10...	18	26	30	43	54	61	76	75	65	54	38	29
11...	18	23	31	43	54	63	76	74	69	52	41	28
12...	16	24	29	43	56	67	74	70	64	53	39	27
13...	20	26	26	44	54	69	76	72	62	54	38	25
14...	17	24	26	44	54	66	76	70	63	54	36	25
15...	18	24	27	45	56	67	77	71	64	55	36	25
16...	19	26	29	48	57	66	74	73	63	54	35	23
17...	21	28	30	49	57	69	75	73	61	52	35	22
18...	19	27	32	46	55	68	73	72	63	51	35	25
19...	20	28	30	48	57	69	75	73	60	52	34	24
20...	21	28	31	49	57	67	75	73	62	51	34	26
21...	20	30	34	48	58	68	77	71	63	50	33	27
22...	18	30	35	51	55	70	76	70	63	50	30	27
23...	16	30	36	51	60	71	76	71	62	48	29	25
24...	18	33	37	48	62	72	77	68	63	48	29	23
25...	18	32	37	50	61	69	75	71	63	49	29	19
26...	19	28	37	52	60	67	76	72	60	47	29	22
27...	19	32	35	54	60	69	76	71	60	46	28	20
28...	20	33	36	51	59	69	75	71	59	46	27	23
29...	20	..	38	50	62	73	76	71	61	43	24	21
30...	20	..	38	50	59	70	77	70	61	46	25	21
31...	18	..	39	..	60	..	73	68	..	45	..	21
Mean	19	26	32	46	56	66	75	72	64	52	36	25

AVERAGE OF DAILY MINIMUM TEMPERATURES FOR 33 YEARS.

Duluth, Minn.

Days.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1...	3	−3	12	23	35	45	53	58	55	44	32	13
2...	−1	0	12	24	35	45	54	58	55	45	32	13
3...	0	−1	11	26	36	45	54	58	53	43	32	14
4...	1	−4	9	26	37	46	54	58	53	43	32	13
5...	6	0	11	28	37	45	54	59	54	41	31	15
6...	6	4	11	28	37	44	56	59	53	42	30	13
7...	3	4	13	27	37	46	57	59	52	43	31	10
8...	1	4	15	29	40	47	57	59	52	42	29	11
9...	−1	1	18	31	40	46	57	59	52	41	28	13
10...	2	2	15	30	39	45	58	58	52	41	28	15
11...	0	3	16	30	38	46	57	58	51	41	27	14
12...	0	2	13	30	40	48	57	57	50	41	26	13
13...	0	4	9	31	38	49	57	57	48	40	25	11
14...	0	2	10	31	39	49	58	58	50	41	24	9
15...	1	2	10	30	38	49	58	57	50	40	25	9
16...	2	3	11	31	38	49	57	59	48	40	23	9
17...	3	6	13	32	40	50	57	58	47	39	20	6
18...	2	4	15	33	40	49	57	57	47	38	21	11
19...	2	5	13	33	41	52	57	58	47	36	21	9
20...	6	5	15	34	41	52	58	58	46	37	20	12
21...	1	7	16	34	41	51	58	57	48	37	21	13
22...	1	7	17	34	42	51	58	56	48	37	19	14
23...	−1	8	15	35	42	52	58	56	47	37	16	9
24...	3	7	21	34	43	53	58	57	47	35	14	8
25...	1	8	20	34	43	53	58	56	47	35	16	5
26...	1	8	21	36	42	51	58	57	46	35	16	4
27...	2	9	21	36	43	51	58	57	45	36	15	4
28...	1	10	21	36	43	52	58	58	44	34	13	8
29...	1	..	22	35	43	52	58	57	45	33	10	6
30...	2	..	24	34	44	53	58	56	46	33	10	3
31...	1	..	25	..	44	..	59	55	..	32	..	5
Mean	2	4	15	31	40	49	57	58	49	39	23	10

TEMPERATURE, DULUTH, MINN.

Mean of Maxima and Mean of Minima (Monthly and Annual), in Degrees Fahrenheit.

Year.	Jan.		Feb.		Mar.		April		May		June	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1874.....	—	—	—	—	—	—	—	—	62	43	66	50
1875.....	9	−14	10	−14	29	7	44	26	58	39	65	47
1876.....	24	3	20	1	29	9	46	30	57	38	64	45
1877.....	19	−2	39	23	31	12	48	32	58	42	64	47
1878.....	28	13	38	24	46	31	51	37	56	40	67	51
1879.....	23	2	19	−1	36	16	49	30	57	40	69	49
1880.....	31	11	24	1	30	9	45	29	62	40	69	51
1881.....	12	−2	22	8	35	21	47	29	59	44	65	49
1882.....	24	6	34	17	35	20	45	32	55	38	68	51
1883.....	11	−9	23	1	32	12	48	33	52	39	68	50
1884.....	15	−6	15	−2	30	11	42	31	58	41	65	50
1885.....	8	−12	15	−6	27	8	46	28	56	39	68	50
1886.....	14	−2	24	3	35	15	46	31	65	43	69	49
1887.....	12	−9	20	0	33	12	47	28	58	42	65	48
1888.....	12	−7	22	3	25	7	45	28	52	35	65	46
1889.....	26	13	18	1	41	26	48	34	58	40	66	50
1890.....	20	5	25	8	30	13	48	33	50	36	66	49
1891.....	28	13	20	4	26	12	47	32	58	39	61	47
1892.....	17	0	24	11	31	16	40	29	50	39	63	49
1893.....	12	−2	16	0	31	14	38	29	54	40	68	52
1894.....	20	5	24	6	36	23	43	33	56	40	73	52
1895.....	15	0	21	4	32	15	48	36	59	41	66	49
1896.....	20	7	26	7	30	14	45	32	62	44	70	52
1897.....	18	1	24	13	29	15	48	32	57	40	63	46
1898.....	26	12	25	10	38	23	47	34	58	43	65	48
1899.....	18	1	15	−2	23	7	47	33	54	39	67	49
1900.....	26	10	16	−2	29	14	53	36	63	44	68	50
1901.....	21	5	18	3	31	18	47	35	58	42	65	49
1902.....	25	8	25	11	38	25	46	32	55	40	64	46
1903.....	21	4	24	5	37	24	46	34	54	41	68	50
1904.....	13	−4	10	−8	26	12	41	27	57	40	65	47
1905.....	14	−3	17	0	33	19	47	29	55	39	64	47
1906.....	26	8	21	1	26	11	52	35	53	37	66	48
1907.....	12	−6	21	2	33	17	38	23	46	31	68	48
1908.....	25	5	24	9	32	15	48	29	56	39	65	48
1909.....	19	1	20	5	32	18	40	24	53	36	70	48
1910.....	21	6	18	−1	48	27	50	33	56	37	77	54
1911.....	16	−6	26	8	37	19	46	30	61	41	70	48
1912.....	1	−15	17	1	27	10	47	30	54	39	68	49
1913.....	16	−4	14	−3	25	9	49	32	55	37	70	49
Means...	18	1	22	4	32	15	46	31	47	40	69	48
High....	31	13	39	24	48	31	53	37	65	44	77	54
Low.....	1	−15	10	−14	23	7	38	23	46	31	61	45

NOTE: During the period Oct. 18, 1870, to December 31, 1903, the height of the thermometers above lake level (which is 601.2 feet above sea level) varied from about 43 to about 175 feet, according to location of the office. Since January 1, 1904, at Weather Bureau Building, the height of the thermometers has been substantially 540 feet above mean lake level, while that of the other instruments has also differed accordingly. These

TEMPERATURE, DULUTH, MINN. (Continued)
Mean of Maxima and Mean of Minima (Monthly and Annual), in Degrees Fahrenheit.

July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual	
Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
78	58	71	58	67	52	54	41	34	18	26	5	—	—
77	57	72	57	62	47	48	34	32	14	31	16	45	26
76	55	74	58	62	49	48	35	36	25	19	−3	46	29
77	59	78	61	67	53	51	40	38	26	38	27	51	35
79	62	79	60	65	48	50	35	43	29	23	9	52	37
78	58	76	59	62	46	58	44	36	21	16	−3	48	30
76	57	72	58	65	49	50	38	26	14	19	5	47	30
81	62	74	61	63	50	52	39	34	20	34	18	48	33
70	54	70	58	65	53	55	44	39	29	23	8	48	34
74	57	70	56	62	48	50	39	37	21	24	7	46	29
70	56	71	58	65	52	55	40	37	21	17	3	45	30
74	57	70	56	62	48	50	39	37	21	24	7	46	29
76	58	73	57	60	44	58	39	37	21	18	0	48	30
77	58	72	54	63	49	50	33	38	22	27	10	47	29
75	55	73	54	64	48	49	38	40	29	32	18	46	29
72	56	72	57	62	48	48	36	37	25	31	20	48	34
75	58	68	54	64	46	50	40	41	28	30	16	47	32
70	53	69	56	70	53	53	40	31	19	34	20	47	32
79	60	75	59	67	52	56	42	32	21	20	8	46	32
76	57	72	57	64	49	51	39	34	23	19	4	45	30
79	58	73	57	68	52	52	41	32	20	32	20	49	34
70	55	73	58	65	50	49	35	35	23	26	14	46	32
76	57	74	56	62	47	48	36	27	14	28	16	47	32
74	58	71	57	70	55	54	43	32	20	21	7	47	32
75	57	70	58	68	50	50	38	36	22	22	5	48	34
73	56	71	59	62	48	54	42	46	35	26	13	46	32
72	57	75	60	66	51	60	48	33	22	26	13	49	34
74	58	74	61	64	51	56	41	36	23	21	8	47	33
74	58	68	56	60	46	53	40	39	29	24	9	48	33
73	56	66	54	62	47	56	41	35	21	18	2	47	32
71	53	70	52	59	45	50	38	42	27	22	7	44	28
71	54	73	57	66	51	48	34	38	23	27	13	46	30
74	56	72	56	70	52	49	35	35	25	22	8	47	31
76	55	69	52	58	45	51	35	37	24	27	12	45	28
73	55	71	53	70	51	53	38	40	35	23	8	48	31
73	55	72	57	64	46	49	36	40	27	18	6	46	30
77	58	71	54	64	47	56	39	29	19	21	4	49	31
75	54	70	52	61	46	49	35	29	14	26	14	47	30
72	54	64	51	63	47	56	37	40	24	27	9	44	28
69	52	70	54	62	46	49	32	43	28	34	19	46	29
74	56	71	57	64	49	52	38	36	23	25	10	47	31
81	62	79	61	70	55	60	48	46	35	38	27	52	37
69	52	64	51	58	44	48	32	26	14	16	−3	44	26

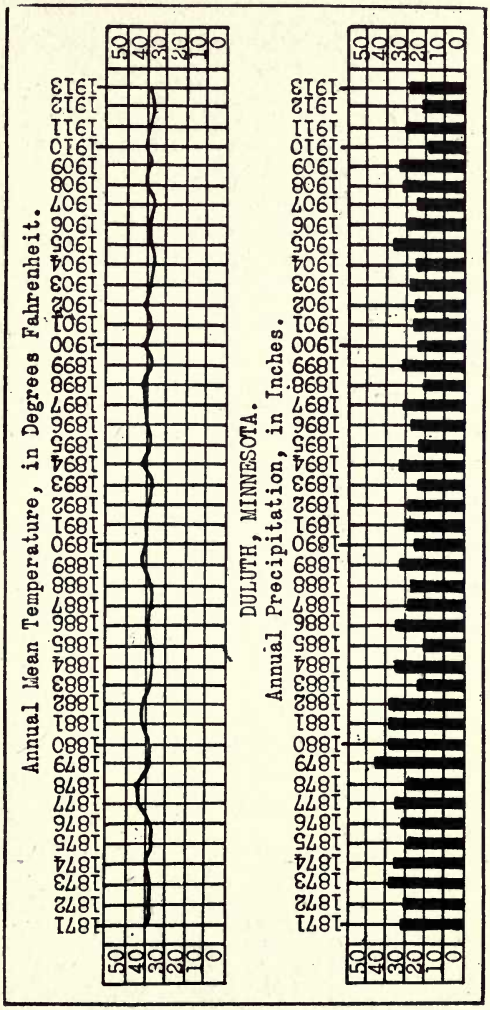
changes in elevation have had some effect on temperature extremes and wind velocities, but the present location is practically ideal for all purposes.

The 12 years, 1874-1888, have rather more than the usual number of low minima for the winter months. It was a cold series of years which may now again begin to recur.

COMPARATIVE DATA.

Monthly and Annual Mean Temperature (degrees Fahrenheit). Duluth, Minn.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
1871...	13	17	29	39	53	60	66	64	56	45	27	7	40
1872...	13	18	18	37	46	60	67	68	56	47	27	5	38
1873...	8	15	26	38	46	58	65	65	53	43	24	20	38
1874...	13	16	24	33	52	58	68	64	59	47	26	15	40
1875...	−3	−2	18	35	49	56	67	64	55	41	23	23	36
1876...	14	10	19	38	48	55	65	66	55	41	31	8	38
1877...	9	31	22	40	50	56	68	69	60	45	32	33	43
1878...	20	31	38	44	48	59	70	70	56	42	36	16	44
1879...	13	9	26	39	49	59	68	67	54	51	28	6	39
1880...	21	13	19	37	51	60	66	65	57	44	20	12	39
1881...	5	15	28	38	51	57	72	68	56	45	27	26	41
1882...	15	25	27	39	46	59	62	64	59	49	34	16	41
1883...	1	12	22	40	45	59	66	63	55	44	29	15	38
1884...	4	6	21	36	50	58	63	64	58	47	29	10	37
1885...	−2	4	17	37	47	58	65	61	56	43	32	20	37
1886...	6	14	25	38	54	59	67	65	52	49	29	9	39
1887...	2	10	22	37	50	56	68	63	56	41	30	18	38
1888...	2	13	16	37	44	56	65	64	56	44	34	25	38
1889...	20	9	33	41	49	58	64	65	55	42	31	26	41
1890...	12	17	22	41	43	58	66	61	55	45	34	23	40
1891...	20	12	20	39	49	54	61	62	62	46	25	27	40
1892...	8	18	24	35	44	56	70	67	59	49	26	14	39
1893...	5	8	23	33	47	60	66	65	56	45	29	11	37
1894...	13	15	29	38	48	63	69	65	60	47	26	26	42
1895...	8	13	23	42	50	57	62	65	58	42	29	20	39
1896...	13	16	22	38	53	61	66	65	55	42	21	22	40
1897...	9	19	22	40	48	54	66	64	63	49	26	14	40
1898...	19	17	31	40	51	57	66	64	59	44	29	13	41
1899...	9	6	15	40	47	58	65	65	55	48	41	19	39
1900...	18	7	22	45	53	59	65	68	59	54	27	20	41
1901...	13	11	25	41	45	57	66	68	57	48	29	15	39
1902...	17	18	32	39	48	55	66	62	53	46	34	16	41
1903...	12	14	30	40	47	59	64	60	55	48	28	10	39
1904...	4	1	19	34	49	56	62	61	52	44	34	14	36
1905...	6	9	26	38	47	56	63	65	59	41	30	20	38
1906...	17	11	18	43	45	57	65	64	61	42	30	15	39
1907...	3	12	25	31	39	58	66	60	52	43	30	20	36
1908...	15	16	23	39	48	57	64	62	60	46	32	16	40
1909...	10	10	25	32	45	59	64	65	55	42	34	12	38
1910...	13	8	37	41	47	66	67	63	56	48	24	13	40
1911...	5	17	28	38	51	59	65	61	53	42	21	20	38
1912...	−7	9	19	39	47	58	63	57	55	47	32	18	36
1913...	6	6	17	40	46	59	60	62	54	41	36	27	38
Mean..	10	13	24	38	48	58	66	64	56	45	29	17	39


Annual Mean Temperature, in Degrees Fahrenheit.
50
40
30
20
10
0
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
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1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
DULUTH, MINNESOTA.
Annual Precipitation, in Inches.

MEAN PRECIPITATION, IN INCHES.

MINNESOTA STATIONS.

(Averages range from 10 to 40 years.)

Stations.	Dec.	Jan.	Feb	Winter Mean	March	April	May	Spring Mean	June	July	August	Summer Mean	Sept.	Oct.	Nov.	Autumn Mean	Annual
Crookston	0.3	0.5	0.7	1.5	1.0	1.8	2.8	5.6	3.8	3.6	3.3	10.7	2.1	2.0	0.7	4.8	22.6
Mount Iron	1.2	1.0	0.7	2.9	1.3	1.9	4.0	7.2	4.6	5.0	4.2	13.8	4.5	3.5	1.4	9.4	33.3
Moorhead	0.7	0.7	0.8	2.2	1.1	2.3	2.6	6.0	4.1	3.9	3.0	11.0	2.2	2.2	0.9	5.3	24.5
Park Rapids	0.7	0.7	0.6	2.0	1.3	2.5	3.6	7.4	4.6	3.9	3.9	12.4	2.0	2.3	0.8	5.1	26.9
Sandy Lake Dam.	0.9	0.9	0.7	2.5	1.5	2.3	3.3	7.1	3.2	4.0	4.1	11.3	2.4	2.6	1.1	6.1	27.0
Duluth	**1.2**	**1.0**	**1.0**	**3.2**	**1.5**	**2.0**	**3.4**	**7.0**	**4.2**	**4.0**	**3.4**	**11.5**	**3.7**	**2.6**	**1.5**	**7.7**	**29.5**
Fergus Falls	0.6	0.6	0.5	1.7	1.2	2.4	2.7	6.3	3.6	3.9	3.0	10.5	2.0	2.0	0.7	4.7	23.2
Morris	0.6	0.4	0.5	1.5	1.0	2.8	2.5	6.3	3.4	4.2	3.2	10.8	2.2	1.5	0.6	4.3	22.9
Collegeville	0.4	0.5	0.4	1.3	1.3	2.4	2.6	6.3	2.9	3.5	2.8	9.2	2.4	1.9	0.8	5.1	21.9
Bird Island	0.6	0.6	0.6	1.8	1.4	2.6	3.0	6.0	3.6	3.3	3.1	10.0	3.3	2.0	0.8	6.1	23.9
Saint Paul	1.2	1.0	0.6	2.8	1.6	2.5	3.3	7.4	4.4	3.6	3.4	11.4	3.3	2.5	1.2	7.0	28.6
Luverne	0.8	0.6	0.4	1.8	1.5	2.4	3.8	7.7	4.3	4.1	3.7	12.1	3.4	2.4	0.8	6.6	28.2
Rolling Green ...	1.2	0.8	1.0	3.0	1.6	3.0	4.0	8.6	3.8	3.1	2.6	9.5	2.8	1.4	1.0	5.2	26.3
Grand Meadow ..	1.1	0.5	0.9	2.5	2.0	2.7	5.0	9.7	5.6	4.3	3.3	13.2	3.4	2.8	1.1	7.3	32.7

Of the stations above shown the annual precipitation at only two exceeds that at Duluth, and one of these is not far distant in St. Louis County. In all these places the bulk of the precipitation occurs in the warmer months, principally in the growing season. The rainfall shows a very even distribution throughout the summer months, while at Duluth and a few other places the amounts of rainfall in May and September are much the same as in the summer months. This even and ample supply of rain from May to including September is in large part responsible for the unexcelled grass and hay conditions in this section besides the splendid crops of all kinds. There is also much sunshine during this period, and the temperature conditions are all that could be desired.

MEAN TEMPERATURES (MINNESOTA STATIONS).

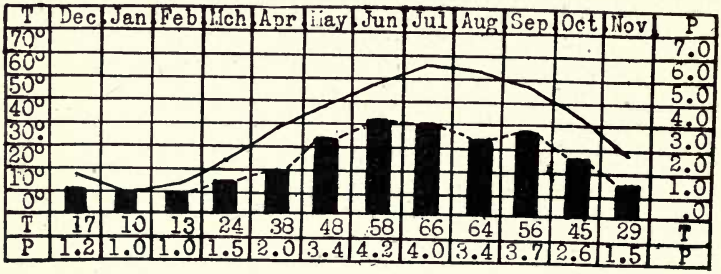
Stations.	Winter				Spring				Summer				Autumn				
	December.	January.	February.	Mean Winter	March.	April.	May.	Spring Mean	June.	July.	August.	Summer Mean	September.	October.	November.	Autumn Mean	Annual
Crookston	11	4	6	7	20	43	55	39	64	69	66	66	56	44	23	41	38
Mount Iron	11	6	9	9	21	41	52	38	60	65	62	62	54	42	22	39	37
Moorhead	12	2	6	7	21	42	54	39	64	68	66	66	55	44	26	42	37
Park Rapids	11	7	7	8	21	41	54	39	62	68	64	65	55	43	24	41	38
Sandy Lake Dam.	12	7	8	9	22	41	54	39	63	67	64	65	56	44	25	42	39
Duluth	**17**	**10**	**13**	**13**	**24**	**38**	**48**	**37**	**58**	**66**	**64**	**63**	**56**	**45**	**29**	**43**	**39**
Fergus Falls	13	9	9	10	24	44	57	42	65	70	67	67	58	46	26	43	41
Morris	15	8	10	11	24	45	56	42	66	71	68	68	60	46	26	44	41
Collegeville	18	14	14	16	28	46	58	44	67	72	69	69	60	49	30	46	44
Bird Island	16	12	13	14	27	46	58	43	66	72	69	67	61	48	29	46	43
Saint Paul	20	12	16	16	29	48	60	46	66	74	72	71	62	50	32	48	45
Luverne	19	17	16	17	29	48	58	45	66	71	69	69	60	49	30	46	44
Rolling Green	20	12	14	15	27	46	57	43	66	72	69	69	60	48	29	46	43
Grand Meadow ...	16	13	13	14	28	46	59	44	67	72	70	70	60	48	31	46	44

A study of the above table clearly indicates the fact that the winter temperatures at Duluth compare favorably with those experienced in the central and southern portions of the State, and that many other places in Minnesota are colder than at Duluth, while so far as summer temperatures are concerned the normal conditions at the head of the lakes are somewhat cooler than those further inland. This latter is due to the prevalent northeasterly winds (off Lake Superior) during the summer months.

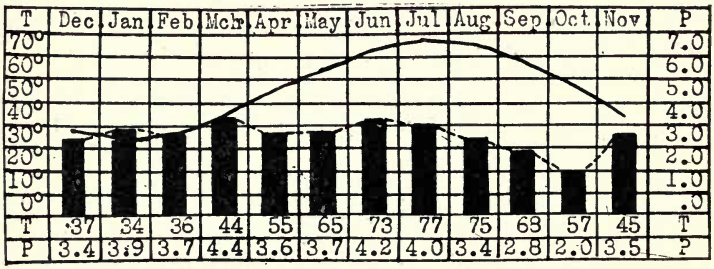
Normal Mean Temperature and Precipitation.

Continuous curve, Mean Temperature, degrees Fahrenheit.
Shaded areas, Mean Precipitation in inches.

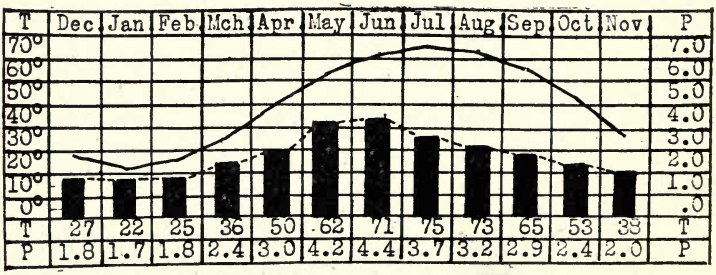
DULUTH, MINN.



OHIO VALLEY STATES.



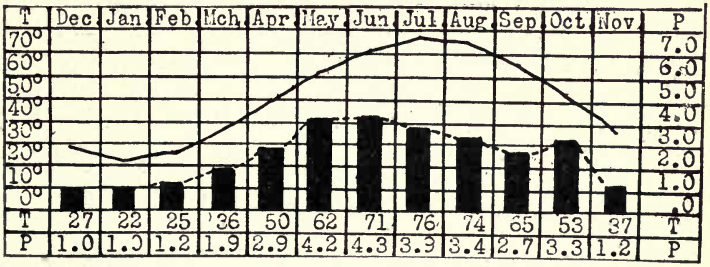
UPPER MISSISSIPPI VALLEY STATES.



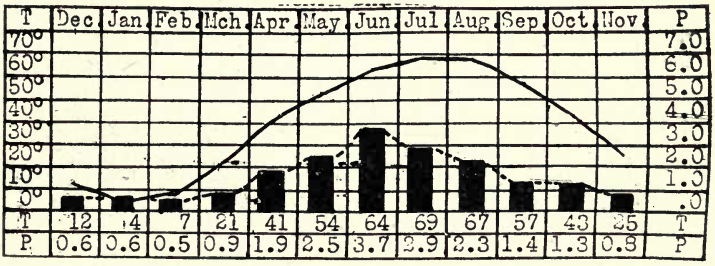
Normal Mean Temperature and Precipitation.

Continuous curve, Mean Temperature, degrees Fahrenheit.
Shaded areas, Mean Precipitation in inches.

MISSOURI VALLEY STATES.



NORTH DAKOTA.



COMPARATIVE PRECIPITATION, IN INCHES.

DISTRICT	Aug.	Sept.	Oct.	Aug. Sept. and Oct.	August and September	September and October
DULUTH, - -	3.4	3.7	2.6	9.7	7.1	6.3
OHIO VALLEY STATES, -	3.4	2.8	2.0	8.2	6.2	4.8
UPPER MISSISSIPPI VALLEY STATES,	3.2	2.9	2.4	8.5	6.1	5.3
MISSOURI VALLEY,	3.4	2.7	3.3	9.4	6.1	6.0
NORTH DAKOTA, -	2.3	1.4	1.3	5.0	3.7	2.7

The foregoing table of average rainfall explains, in great measure, why grass is green and luxuriant at the head of the lakes during the Autumn months, while at the same time in other sections pastures may be brown and bare and stock feeding necessary. Note the moderate mean temperature at Duluth in comparison with the high mean temperatures in June, July, August and September, in the Ohio, Upper Mississippi and Missouri Valley States as shown on Chart, pages 42, 43.

The Ohio Valley averages (see also Chart, page 42) include the following places: Chattanooga, Knoxville, Memphis, Nashville, Lexington, Louisville, Evansville, Indianapolis, Cincinnati, Columbus, Dayton, Pittsburg, Parkersburg and Elkins.

The Upper Mississippi Valley averages include: Minneapolis, St. Paul, La Crosse, Madison, Charles City, Davenport, Des Moines, Dubuque, Keokuk, Cairo, La Salle, Peoria, Springfield (Ill.), Hannibal and St. Louis.

The Missouri Valley averages include: Columbia (Mo.), Kansas City, St. Joseph, Springfield (Mo.), Iola, Topeka, Lincoln, Omaha, Valentine, Sioux City, Pierre, Huron and Yankton.

The North Dakota averages include; Moorhead, Bismarck, Devils Lake and Williston.

SUMMER STATISTICS

Comparative Sunshine Conditions

City.	Latitude.	Hours of Possible Sunshine from May 10 to Sept. 30	Duluth's Excess of Possible Hours of Sunshine from May 10 to Sept. 30	Duluth's Possible Excess per Day, in Minutes May 10 to Sept. 30.	Average Last Killing Frost in Spring	Average First Killing Frost in Autumn
Duluth	46°-47'	2069.6			May 3	Oct. 4
St. Paul	44°-58'	2045.1	24.5	10	May 6	Oct. 5
Des Moines	41°-35'	2024.4	45.2	19	Apr. 28	Oct. 8
St. Louis	38°-38'	1982.2	87.4	36	Apr. 4	Oct. 29

Comparative Temperature Conditions

Place.	June			July			August			Average Number of Times Daily Maximum reaches or exceeds Excessive Temperatures per Summer		
	Average Monthly	Mean Highest Day	Mean Lowest Day	Average Monthly	Mean Highest Day	Mean Lowest Day	Average Monthly	Mean Highest Day	Mean Lowest Day	90°	95°	97°
DULUTH, MINN. .	58°	69°	48°	66°	74°	56°	64°	71°	57°	2		
St. Paul, Minn....	66°	77°	58°	74°	83°	62°	72°	80°	60°		3	
Bismarck, N. D...	64°	75°	53°	70°	82°	58°	68°	81°	55°		6	
Milwaukee, Wis. .	64°	72°	55°	70°	78°	62°	69°	76°	61°	10		
Chicago, Ill.	66°	74°	59°	72°	80°	65°	71°	77°	65°		2	
Detroit, Mich. ...	67°	76°	58°	72°	81°	63°	70°	79°	61°	8		
Cleveland, Ohio ..	67°	75°	59°	72°	80°	64°	70°	77°	62°	5		
Buffalo, N. Y.....	65°	72°	57°	70°	76°	63°	68°	76°	61°	1		
New York City...	69°	77°	61°	74°	82°	67°	73°	80°	66°	8		
Boston, Mass.	66°	75°	57°	72°	80°	63°	70°	78°	62°	9		
Washington, D. C.	73°	83°	63°	77°	87°	68°	75°	84°	66°		8	
Pittsburgh, Pa. ...	71°	82°	61°	75°	85°	65°	73°	83°	63°		4	
Louisville, Ky.	75°	84°	66°	79°	88°	69°	77°	86°	67°		17	
Memphis, Tenn. ...	78°	87°	69°	81°	90°	72°	80°	88°	71°		10	
St. Louis, Mo.....	76°	84°	66°	80°	88°	71°	78°	86°	69°		15	
Kansas City, Mo..	74°	83°	64°	78°	87°	69°	76°	86°	67°		12	
Omaha, Neb.	72°	81°	62°	76°	86°	67°	74°	84°	65°			6
Atlanta, Ga.	76°	85°	67°	78°	87°	70°	77°	85°	69°		5	
Jacksonville, Fla.	80°	89°	72°	82°	91°	74°	82°	90°	74°		14	
New Orleans, La..	81°	87°	74°	83°	89°	76°	82°	88°	75°		4	

The foregoing figures afford an interesting comparison between Duluth and other sections of the country to the eastward of the Rocky Mountains as regards average temperature conditions. These averages cover periods of thirty years or more at places selected. A temperature of 90° or higher (in the shade) is an uncommon occurrence at Duluth, in fact there have been numerous summers without such temperature. The locality at the head of the lakes is peculiarly free from the 10 days to 2 weeks periods of debilitating and blistering heat that afflicts other section at various times during the summer. Our summer weather is accompanied by much clear sky, the temperature during the day is comfortably warm without being hot and the nights are delightfully cool. One can always get a good night's rest and blankets are generally necessary.

SUNSHINE CONDITIONS, SELECTED DATES.

(Growing Season.)

Duluth, Minn.

Dates.	Time of Sunrise *	Time of Sunset *	Period of Possible Sunlight
May 1st	4:52 a. m.	7:18 p. m.	14 hrs. 26 mins.
May 10th	4:37 a. m.	7:30 p. m.	14 hrs. 53 mins.
May 20th	4:26 a. m.	7:42 p. m.	15 hrs. 16 mins.
May 31st	4:17 a. m.	7:54 p. m.	15 hrs. 37 mins.
June 1st	4:16 a. m.	7:55 p. m.	15 hrs. 39 mins.
June 10th	4:13 a. m.	8:02 p. m.	15 hrs. 49 mins.
June 21st †	4:12 a. m.	8:07 p. m.	15 hrs. 55 mins.
June 30th	4:16 a. m.	8:07 p. m.	15 hrs. 51 mins.
July 1st ‡	4:17 a. m.	8:06 p. m.	15 hrs. 49 mins.
July 10th	4:23 a. m.	8:03 p. m.	15 hrs. 40 mins.
July 20th	4:33 a. m.	7:55 p. m.	15 hrs. 22 mins.
July 31st	4:46 a. m.	7:43 p. m.	14 hrs. 57 mins.
August 1st	4:47 a. m.	7:41 p. m.	14 hrs. 54 mins.
August 10th	4:58 a. m.	7:28 p. m.	14 hrs. 30 mins.
August 20th	5:12 a. m.	7:11 p. m.	13 hrs. 59 mins.
August 31st	5:26 a. m.	6:50 p. m.	13 hrs. 24 mins.
September 1st	5:27 a. m.	6:48 p. m.	13 hrs. 21 mins.
September 10th	5:39 a. m.	6:31 p. m.	12 hrs. 52 mins.
September 22nd §	5:55 a. m.	6:06 p. m.	12 hrs. 11 mins.
September 30th	6:06 a. m.	5:50 p. m.	11 hrs. 44 mins.

*Central Standard time.

†Summer Solstice, longest day.

‡Aphelion, greatest distance from sun.

§Autumnal Equinox.

The periods of morning and evening twilight in this latitude are anywhere from 1 to about 2 hours each, much depending upon the state of the atmosphere.

SUNSHINE CONDITIONS, SELECTED DATES.

(October 1 to April 30.)

Duluth, Minn.

Dates.	Time of Sunrise *	Time of Sunset *	Period of Possible Sunlight
October 1st	6:07 a. m.	5:48 p. m.	11 hrs. 41 mins.
October 10th	6:19 a. m.	5:31 p. m.	11 hrs. 12 mins.
October 20th	6:33 a. m.	5:12 a. m.	10 hrs. 39 mins.
October 31st	6:50 a. m.	4:54 a. m.	10 hrs. 4 mins.
November 1st	6:51 a. m.	4:52 p. m.	10 hrs. 1 min.
November 10th	7:04 a. m.	4:40 p. m.	9 hrs. 36 mins.
November 20th	7:19 a. m.	4:29 p. m.	9 hrs. 10 mins.
November 30th	7:32 a. m.	4:21 p. m.	8 hrs. 49 mins.
December 1st	7:34 a. m.	4:21 p. m.	8 hrs. 47 mins.
December 10th	7:43 a. m.	4:19 p. m.	8 hrs. 36 mins.
December 21st †	7:51 a. m.	4:21 p. m.	8 hrs. 30 mins.
December 31st	7:54 a. m.	4:28 p. m.	8 hrs. 34 mins.
January 1st ‡	7:54 a. m.	4:30 p. m.	8 hrs. 36 mins.
January 10th	7:52 a. m.	4:39 p. m.	8 hrs. 47 mins.
January 20th	7:46 a. m.	4:53 p. m.	9 hrs. 7 mins.
January 31st	7:34 a. m.	5:09 p. m.	9 hrs. 35 mins.
February 1st	7:33 a. m.	5:10 p. m.	9 hrs. 37 mins.
February 10th	7:21 a. m.	5:24 p. m.	10 hrs. 3 mins.
February 20th	7:04 a. m.	5:40 p. m.	10 hrs. 36 mins.
February 28th	6:50 a. m.	5:52 p. m.	11 hrs. 2 mins.
February 29th	6:48 a. m.	5:53 p. m	11 hrs. 5 mins.
March 1st	6:48 a. m.	5:53 p. m.	11 hrs. 5 mins.
March 10th	6:31 a. m.	6:06 p. m.	11 hrs. 35 mins.
March 21st §	6:09 a. m.	6:22 p. m.	12 hrs. 13 mins.
March 31st	5:49 a. m.	6:36 p. m.	12 hrs. 47 mins.
April 1st	5:47 a. m.	6:37 p. m.	12 hrs. 50 mins.
April 10th	5:29 a. m.	6:49 p. m.	13 hrs. 20 mins.
April 20th	5:11 a. m.	7:03 p. m.	13 hrs. 52 mins.
April 30th	4:54 a. m.	7:16 p. m.	14 hrs. 22 mins.

*Central Standard time.
†Winter Solstice, shortest day.
‡Perihelion, Earth nearest to Sun.
§Vernal Equinox.

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